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Rheumatic heart disease and pregnancy

Edith. Eason

University of Nebraska Medical Center

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RHEUMATIC HEART DISEASE

AND

PREGNANCY

by

Edith Eason

Senior Thesis

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The College of Medicine,
University of Nebraska.
Omaha

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INTRODUCTION

"We know that we do not know what any given heart will do in pregnancy or labor until it has done it." Kellogg (40) made this statement in 1917, and now, as then, it is strikingly true. As early as 1878 Macdonald (46) stated that deaths of cardiac patients during pregnancy and delivery were due to the "Cramping effects of a too rigid specialism, thus concentrating the attention of the obstetrical practitioner exclusively upon matters purely obstetrical and gynecological... As every woman has not only a uterus and ovaries, but also a liver, heart, lungs, kidneys, etc., it is the first duty of every obstetrician to make sure that he is a physician in the first instance, and an obstetrician only in the second place." I will attempt to present observations related by obstetricians and cardiologists --and surely today no one attempts to form opinions on the subject unless he feels himself to be both.

The material will be discussed under several different headings, although these headings cannot be considered as separated one from another. The load carried by any heart in pregnancy will first be taken up, but in so doing I realize how inadequate and inconclusive the information on this phase of the subject is at the

present time. Such a discussion is necessary in order to show the effect of rheumatic heart disease on pregnancy; and, conversely, pregnancy on rheumatic heart disease. I will next summarize the available data with regard to the incidence of rheumatic heart disease in pregnancy and the diagnosis thereof. I will then review the various methods that have been suggested for classifying this condition, and in what manner these classifications may apply to prognosis. The complications of this disease and the resulting mortality will be presented, as well as the outstanding viewpoints for management of such a pregnancy and labor. All authors apparently agree on the uncertainty which is attached to every case, and most certainly this is a subject about which no hard and fast rules can be presented. Was there ever a patient so afflicted whose signs, symptoms, or pathology really corresponded to another?

As will be shown by the incidence of rheumatic heart disease, by far the greatest number of heart cases encountered in pregnancy are of rheumatic origin. Consequently, in this paper, as in the majority of literature, unless otherwise stated "heart disease" refers to "rheumatic heart disease".

The history of the development of this subject

will be discussed briefly under the different arbitrary headings just mentioned.

I would like to mention here a few of the men who early had a profound influence on the subject. Many accepted maxims were based only on the impressions of the early authors, and finding their way into the literature they were simply copied from paper to paper. Regardless, hardly a paper has been written on this subject from 1878 until 1918, and even to the present time, that reference has not been made to Angus Macdonald (46) of Edinburgh who in 1878 published a description of 29 pregnant women with severe heart disease. His work literally governed the subject until Mackenzie (49) in 1918 published material based on 35 years of study. In the meantime, however, (1907), Hicks and French (33) published their conclusions based on 300 cases of rheumatic heart disease which they had observed; but these conclusions were with regard to the likelihood of sterility, tendency to abort, etc., which after all were of no aid in the really important issue--the management of such patients during pregnancy and delivery. Pardee (60) in 1922 was the first to recognize the importance of classifying patients by their functional capacity rather than by valvular defects, that thereby certain

LOAD OF THE HEART IN PREGNANCY

It is generally assumed that the work of the heart is increased during pregnancy, but it is much easier to accept this assumption than to explain its causes. Two observations support this: (1) women with apparently normal hearts may, during pregnancy, develop symptoms and signs of cardiac distress, and (2) cardiac distress from any cause may be promptly relieved by delivery. "There is little agreement on the nature of the mechanism which causes this increase in cardiac work, or the manner in which the heart meets the increased demands, or upon the effect which these changes have upon the heart." (39)

A great deal of information about this is available in the literature of the last 20 years, but it is scattered and often contradictory. A fairly complete survey is necessary to arrive at any practical conclusions.

In 1921 Mackenzie (48) criticized the attitude of the obstetricians toward modern cardiology in their apparent disinterest toward the reaction of the normal heart in normal pregnancies, which, as Carmeltoft (29) pointed out, is certainly necessary in order to account for the heart action in the various diseases of pregnancy.

Some of the factors considered in the explanation of how cardiac work is increased during pregnancy are the general increase in body weight; the effect of the mechanical pressure of the growing uterus; the changes in respiratory volumes, particularly the vital capacity; the caloric demands of the growing ovum; increase in vascular resistance caused by the growing uterus; changes in the peripheral vessels caused by pregnancy; increase in metabolism; and increase in blood volume.

There certainly can be no disagreement that the heart of the pregnant woman must meet the circulatory needs of two organisms instead of one; and it is commonplace to say that this situation must increase the work of the heart. Gammeltoft (29) asks the question, "How does the circulatory system of the mother, especially the heart, react toward the new task, the increased work, with which it is encumbered during pregnancy?"

Burwell in 1936 reported a rather complete account of studies he and his associates made on the circulatory adjustments to pregnancy. He related that these changes are due mainly to two mechanical alterations in the circulation of pregnant women. One of these mechanical changes is the obstruction offered by the enlarging uterus to the return of blood from the

legs. The other is the development of new channels in the placenta which conduct a large current of blood from the arterial system through the placenta into the venous system. This new circulation leads the blood from arteries to veins without the interposition of arterioles or capillaries. Burwell compared the burden which pregnancy imposes upon the heart as similar to the burden imposed by an arteriovenous fistula of considerable size -- the heart may be overburdened by the necessity of adjustment to such an arteriovenous leak. These changes in the circulation of the pregnant woman are present "when she is at work and when she is at rest -- at night as well as by day". When she lies at bodily rest as complete as she can make it her heart does more than that of a non-pregnant woman, and when she exerts herself, the heart rate and the cardiac output increase in proportion to her effort more than they would on similar work by a non-pregnant woman.(8) Smith's work published in 1922 (73) indicated, however, that the reserve of the heart is so great that such normal women or those with mild involvement of rheumatic heart disease go through pregnancy without ever coming near the edge of their reserve and, therefore, without developing symptoms of cardiac failure. Increased cardiac work is a necessary consequence of pregnancy, and whenever the total load becomes greater than a given

heart can carry effeciently (as may happen in valvular disease), then symptoms appear, or the limit may be reached.

Stander in 1932 (74) and Danforth in 1938 (17) measured the cardiac output in test animals and in women during pregnancy, and found that the amount of work done by the heart increased from the fourth month of pregnancy, until at term about 50% more work was done than in the non-pregnant state. Stander found that the work of the heart reaches normal about three weeks after delivery. White (86) in 1934 estimated that the work of the heart is about 25% greater during pregnancy than during the puerperium.

The increase in weight during pregnancy seems such an obvious cause of increase in cardiac work that little attention has been paid to it. Yet, as early as 1871, James Young (92) wrote that the increased physical load of pregnancy must increase the work of the heart simply by increasing the work of the muscles of locomotion.

Instead of being generally distributed over the body, however, the gain in weight is so largely localized that certain postural difficulties are the result, which further increase the work of the heart. Two

observations made by Jensen (39) indicate that the load which the increase in weight places on the heart is not the important cause of cardiac embarrassment:

(1) There seems to be an increase in cardiac output long before the increase in weight can make itself felt, and cases were recorded by Miller (55) in which pregnant women with heart failure have been relieved of their symptoms following the death of the fetus, though the latter was not expelled for some time afterward.

In 1939 Clahr, Greenstein and Klein (13) found that there was an increase in the minute volume of the heart from a minimum of 15% to a maximum of 74% from the fourth month of gestation onward. In the same year, Meares (54) reported the minute volume of the heart increased by 60%, and, previous to this, in 1936 Burwell (7) related an increase of 40-50% above the usual normal figure. This one might expect to be similar in degree to the rise in oxygen consumption, but they found it to be considerably greater.

Nothing would be gained by discussing the change of the basal metabolic rate and its effects to increase the load of the heart, due to the fact that so many different opinions as to methods of testing and interpretation of results have appeared that it would

only be confusing to attempt to review these. The recent literature probably indicates that there is an increase in oxygen consumption which exceeds the basal metabolic rate to some extent.

Many authors, including Gammeltoft (29); White (85); Clahr, Greenstein and Klein (13); Darchinan and Kornfeld (19); Rowntree and Keith (55); and, according to Burwell, Thomson, Hirsheimer, Gibson and Evans (7) have reported an increase in the total volume of blood in the body during pregnancy. This, according to the work of the latter four men, rose to an average of 24%. As Jaschke (36) pointed out the methods of directly experimenting with such are not feasible in human beings, and the indirect methods which have been developed all suffer from serious defects. The available evidence from the various methods devised for such testing nevertheless indicates that toward the end of pregnancy the heart has to carry a load of circulating blood which is 400 to 1200 cc. greater than in the non-pregnant state. According to Jensen, only Koch and Jakabitz did not find an increase in blood volume in pregnancy and their figures are disproportionately low. (39)

A discussion of the load which any heart carries during pregnancy would not be complete without

mentioning the response of the heart to this load, namely, whether or not cardiac hypertrophy and dilatation do occur. Speculations were made on this subject over a century ago. The problem was called "barren and academic" by Mackenzie (49) in 1908, but it has nevertheless continued to be the subject of discussion.

In 1878 Macdonald (46) stated that confusion existed as to whether or not the heart actually hypertrophied during pregnancy, but partly by force of single personal observation and partly because "so many observers could not be misled" he accepted a slight cardiac hypertrophy.

In 1907 Breed (5) related that it is "still a matter of argument if the heart hypertrophies during pregnancy."

In recent years by the aid of electrocardiography and roentgenography as well as more available postmortem material the results should be more conclusive; regardless, as with the majority of phases of this subject, there is a great diversity of opinion. In 1938 Jensen (39) wrote that the subject "needs amplification by means of more recent and plentiful material". Meares in 1939 (54) maintained that electrocardiographic examinations have shown that the left side

of the heart does undergo relative hypertrophy during the first 6 months compensated by a relative hypertrophy of the right side of the heart in the last 3 months. Probably on the right side there is also some degree of dilatation.

The conclusion which is based on modern literature is that the heart does increase in size as pregnancy advances. Gammeltoft (29) goes so far as to say that this is specifically a result of the increased total amount of blood and increased minute volume. The only men denying this are Wilson and Herrmann (90), Smith (73), Mackenzie, and, according to him, Stengel and Stanton (49).

The consensus of opinion seems to be that cardiac output is increased during pregnancy, that 25% to 50% more work is done by the heart in the pregnant than the non-pregnant state, that there is an increase in the minute volume of the heart, that there is a rise in the basal metabolic rate, and that there is an increase in the total volume of blood to about 24% over the usual volume.

INCIDENCE

Rheumatic heart disease is prevalent in central, northern and western Europe including northern Italy. In the United States it prevails in the damp cold areas of the East, and is much less common in the arid, warm areas of the southwest. Harrison and Levine (45) found the incidence relatively low in the middle west, and Hanley (34) and Hamilton (33) found it very low in Southern California. It is rare in Australia and South America.

Rheumatic heart disease is not notifiable. For this reason its incidence among childbearing women is not absolutely known but must be estimated from the incidence of rheumatic heart disease among potential mothers, women of childbearing age - so far as can be ascertained - and from the recorded experience of various clinics and districts.

Jensen (38) in 1936 studied the incidence of rheumatic heart disease and found that all available data falls into three groups. By anatomical examination, the highest incidence, 6% to 9%, was found. An incidence of between 2% and 3% was found by most of the methods based on simple physical examinations. The lowest incidence, less than 1%, is indicated by statistical evidence. The anatomical lesions are most likely

to be scientifically correct, but in a high percentage of these cases the lesions did not contribute to the death of the patient. By physical examinations of large numbers of persons functional murmurs may easily be mistaken for organic heart disease. Probably the statistical methods, indirect though they may be, come closer to the truth and the incidence of rheumatic heart disease among white women of childbearing age in this country is assumed to be between 0.6 and 1.0%. However, the incidence varies markedly in the various sections of the country. From a practical point of view, the obstetrician would restrict the term "rheumatic heart disease to conditions which may become dangerous to childbirth".(39)

Roughly speaking, two views are held regarding the seriousness of pregnancy in the cardiac patient. Those with a favorable experience tend to optimism, while those who have witnessed the catastrophies of the complication lean to the opposite view. The attempts to test these views by statistical methods have caused a great deal of argument. To understand the reason for this difference of opinion, it is necessary to go back some sixty years.

Augus Macdonald (47) in 1878 was the first author to call attention to heart disease in pregnancy.

He reported 29 cases which he had either observed or collected. These early series of cases contained only very sick patients and the death rate was appalling. For instance, Macdonald (47) and Hart (35) reported a mortality of 64% and 60% respectively. These early authors based their conclusions on series of cases of advanced heart disease and applied them to heart disease in general. In the analysis of statistical results it is necessary always to be on guard against such unfair sampling.

In 1888 Fry (28) stated that but one of two excuses could justify the indifference to the subject of heart disease in pregnancy. He believed that either there did not exist any special indication for the treatment of this complication, or it was of such rare occurrence that cases should be classed "among the curiosities of one's obstetrical experience".

About the beginning of the 20th century, the death rate came to be computed, not on the basis of a few accidentally collected severe cases, but on the total number of cardiac patients within a given group of pregnant women.(83) The results now become more favorable.

In Germany the method of collecting statistics from hospital records reached its climax with the

works of Fellner in 1901 and Jaschke in 1910.(36)

"But experience is fallacious and judgment difficult".(39)

Unfortunately, criticism did not stop at methodical errors but discredited the whole principle of statistics.

Soon it became a standing phrase that each case must be judged individually - whereupon the authors generally proceeded to analyze their data by the very statistical methods which they had just denounced.

The best defense of statistics in the study of heart disease in pregnancy was made by Kellogg in 1917.(40) In general, as soon as the existence of a relation between two factors is doubtful, it becomes a proper subject for statistical analysis; without this, statements can be based only on impressions and "feelings". The literature on obstetrical cardiology is filled with such unsupported opinions.

"Statistics are no substitute for clinical experience and mature judgment, but they do express the essence of accumulated experience, and as such are a guide for the clinician." (40)

In 1923, Hamilton of Boston (33) reported the incidence of rheumatic heart disease as 1%, which was the same as Campbell's report.(9) Daly (16) in 1924 reported 2.8%. In Carr and Hamilton's series (11) in 1933 of 45,069 deliveries they found 1.11% of these

patients to have seriously damaged hearts of which 94.4% were of rheumatic origin. Reis (64) reported that 1.13% of all the patients delivered at Micheal Reese Hospital from 1930-1935 suffered from rheumatic heart disease. The literature indicates that in the past two years the incidence is again being reported as slightly higher, although the geographic distribution of the disease must be taken into consideration. Meares of Australia (54) reported the incidence as 1%. Of 14,009 pregnancies (1932-1937) reported by Stander (76) at the New York Lying-In Hospital, 3% were complicated by rheumatic heart disease. Of 2,200 cases at the St. Louis City Hospital Jensen (39) found an incidence of 1.86%. Four per cent was reported by Gulick (32) of New Jersey for the same period of years, and King (43) of Ohio reported the incidence as 1% in 1939. Conclusive data is not available for Western United States.

In conclusion it may be said that the methods for determining the incidence of rheumatic heart disease are, as yet, inadequate but it is probably between 0.6% and 1.0% among white women of childbearing age in this country. It is higher in damp, cold areas, and comparatively rare in warm climates.

THE RELATION OF RHEUMATIC FEVER TO HEART DISEASE

The eventual success of the attack which is being inaugurated in this country against rheumatic fever is the most important measure to wipe out almost in its entirety the problem of heart disease in pregnancy.(84) From the point of view of prophylaxis, we must begin in early life. The adolescent is particularly susceptible to the rheumatic virus, and her health should be carefully supervised, in an effort to prevent rheumatic fever, chorea, tonsillitis, and their complications. The prevention of rheumatic disease by tonsillectomy is quite a debatable question. Schuman (69) in 1935 urged that the operation be done routinely in very young children. Better hygiene among the poor is necessary before a reduction in heart disease may be expected. When one considers the numerous specialists concerned from the beginning to the end of this great problem, the pediatrician, the hygienist, the general practitioner, the internist, the cardiologist, the anaesthetist, and the obstetrician, one begins to realize the tremendous scope. It is only by the perfect cooperation between these various branches and by careful research into every aspect of this problem, "that we can hope to reduce the great toll of lives sacrificed on the alter

of motherhood by reason of a diseased heart".(69)

There can be no doubt that acute rheumatism is the result of an infection, though bacteriologists are not agreed as to the identity of the infective agent. The infection may attack the joints, giving rise to acute articular rheumatism; it may attack the nervous system producing chorea; often it attacks the heart, affecting valves, muscle, and pericardium. In older literature rheumatic carditis was described as a complication of acute articular rheumatism or chora; but Bramwell and Longson (4) in 1938 suggested that it be regarded as a collateral manifestation. They stated, contrary to common belief, that in chronic rheumatic heart disease, a history of repeated attacks of rheumatic fever does not add to the gravity of the prognosis.

Mitral stenosis is by far the commonest valvular lesion of rheumatic involvement. In Bramwell's 293 cases (3) of mitral stenosis, this lesion was present alone in 260 and in combination with other valvular lesions in 33.

Not infrequently, it is discovered in the course of a routine examination, in patients who previously had been unaware of any cardiac disability. Of 106 patients from 1923 to 1925 in the cardiac clinic of Lying-In

Hospital in New York 64 were diagnosed as mitral stenosis, 29 mitral insufficiency, and 11 aortic insufficiency and mitral stenosis of rheumatic origin. Ninety-eight per cent of the cardiac patients in this series were traced and found to be rheumatic in origin.

In a similar series of 102 cases referred to the cardiac clinic of Massachusetts General Hospital from the Boston Lying-In Hospital (1920-1922), Breed (5) and White (85) found 68% to be mitral stenosis, 19% mitral stenosis and aortic insufficiency, 9% mitral involvement without demonstrable stenosis, 2% mitral stenosis with aortic regurgitation and stenosis, and 2% non rheumatic in origin.

White (85) in 1931 stated that "The large majority of pregnant women with real heart disease have chronic rheumatic valvular defects, mostly mitral disease with more or less stenosis". He found only about 4% to be congenital defects, luetic aortitis, hypertension, subacute bacterial endocarditis, and thyrotoxicosis; the remainder being rheumatic in origin. The period of life during which a woman may become pregnant is also the period during which rheumatic heart disease runs its course. Dr. Heihaus (57) reported that it is responsible for at least 90% of the heart disease complicating pregnancy.

Mitral stenosis is recognized as a dangerous complication in pregnancy. Sir James Mackenzie (49) studied the subject to see if he could ascertain the reason for the danger and published his work in 1918. He began with cases suffering from rheumatic fever, watched them for years, and found that after an attack of rheumatic fever there was never evidence of mitral stenosis at the beginning. The symptoms of stenosis never appeared until years after the damage was done by the rheumatic fever. The reason is that there first occurs an ulceration of the mitral valves which heals by cicatrization, and it is the amount of damage done to the valve that constitutes the danger. If the case is a severe one and cicatrization occurs rapidly, the murmur of mitral stenosis appears within a year or two of the causative attack of rheumatic fever, but at first there is no presystolic murmur, though there may be a systolic murmur. The first sign of the presence of mitral stenosis is a thrill before the apex beat. Later there appears a short presystolic murmur, not always present; then, as the disease progresses and the narrowing becomes greater, the presystolic murmur becomes long and persistent. When the narrowing becomes still more advanced, there appears, in addition to the presystolic murmur, a diastolic murmur. The presystolic

murmur is due to the obstruction at the mitral orifice during auricular systole as the blood passes into the ventricle. The diastolic murmur is due to the fact that the blood accumulates in the auricle during ventricular systole and the rush of blood into the ventricle at the end of ventricular systole causes the murmur.

Therefore, in a patient with a short presystolic murmur, there is only a small degree of stenosis, and with a long presystolic murmur there is a greater degree of stenosis. Consequently, when a woman presents herself who twenty years before had rheumatic fever, and there is a short presystolic murmur, the prognosis is good, because a long period has supervened since the causative attack of rheumatic fever, and the stenosis is slight in degree and the cicatrization is slow. Conversely, if the patient has a long presystolic murmur, and in addition a diastolic murmur, then the stenosis has become very great. (48)

By way of conclusion, it may be stated that from 90% to 98% of all heart disease encountered in pregnant women is rheumatic in origin. This is mainly mitral stenosis. These patients may or may not have been aware of any cardiac disability.

DIAGNOSIS OF RHEUMATIC HEART DISEASE IN PREGNANCY

Cases for decision come to the attention of the physician for two reasons: either because of the subjective symptoms of dyspnea, palpitation, fatigue, etc.; or because of the presence of cardiac enlargement, murmurs of one sort or another, tachycardia or arrhythmia. These may be signs found in routine examination of the chest, which abnormalities may or may not be associated with subjective symptoms. Each of these cases must first be classified either as one of organic heart disease, or as one having a normal heart in the presence of effort syndrome, irritable heart, or neurasthenia. A clear history of rheumatic fever or chorea in the past should make one very suspicious of heart disease because of the large percentage of such individuals with cardiac damage.

Symptomatology alone does not help, since there are no pathognomonic symptoms of heart disease. Dyspnea, precordial pain, and palpitation may all occur in an effort syndrome or other conditions not true heart disease. Definite pathognomonic signs should be searched for: (1) cardiac enlargement, (2) diastolic murmur heard anywhere over the precordium (mitral stenosis or aortic regurgitation), (3) a loud systolic murmur at the apex masking the first sound (mitral

regurgitation), or (4) auricular fibrillation.(5)

In diagnosing rheumatic heart disease in pregnancy, Jensen (37) regards (1) a history of rheumatic fever as suggestive, (2) that dyspnea, tachycardia, and edema may be produced by pregnancy but in the presence of heart disease they indicate that a damaged heart is becoming embarrassed, (3) that cardiac enlargement is of diagnostic value only when definite and (4) a presystolic murmur at the apex or a diastolic murmur over the aortic area are of positive diagnostic importance.

Niehaus (57) stated that in general, the degree of heart enlargement and the degree of cardiac deficiency are closely parallel. In rheumatic heart disease the cardiac silhouette must be scanned for changes in shape. The enlargement is not generalized early in its course. Harrison (54) pointed out that the large heart is an inefficient heart, while Levine wrote, "The larger the heart the other things being equal, the poorer the prognosis".(45)

CLASSIFICATION AND ITS VALUE IN PROGNOSIS

Many attempts have been made to set up standards whereby prognosis could be guided. There has been much discussion as to whether the prognosis should be based upon the structural change in the heart or upon its functional capacity. Lamb (44) and Jensen (39) used functional classification as one of the many factors in the prognosis. It is true that this procedure is not perfect, for it neglects the importance of certain structural and functional changes in prognosis, and it does not allow for the effect which pregnancy itself may have on the functional state. As early as 1894, Sears (71) suggested a prognostic classification based on the functional ability of the patient. Similar classifications have been used by others, but the first system to gain wide acceptance was the one which Pardee proposed in 1922.(60) It was fundamentally the classification proposed by the American Heart Association a few years later but was modified by the effect of pregnancy and the response to a certain effort (dumbbell swinging).

The subjective complaints of the patient as she goes about her ordinary life, and the subjective reactions to a test exercise performed at the time of her visit to

the physician are used for the grouping. Pardee ascertains the patient's symptoms when walking, house cleaning, and climbing stairs to find how much she is restricted in her activities by the appearance of shortness of breath or palpitation. He then has her exercise, standing with feet separated and swinging a ten pound dumbbell held in both hands from over her head to as near to the floor as she can conveniently reach, repeating each movement about once every two seconds. This swing can usually be repeated twenty times without difficulty, but the patient is carefully watched, and stopped if there is marked flushing or evident dyspnea or distress.

Pardee found that a normal pregnant woman could swing a ten pound dumbbell twenty times without distress and with only a slight sense of breathlessness. There should be only slight abjective dyspnea, an acceleration of the pulse to a rate of 120 a minute or less, and by the end of one minute the respiration should be normal and the pulse nearly so, the pulse returning quite to its normal level at the end of two minutes. If 20 swings of a 10 pound weight causes evident distress, as shown by flushing or an anxious facies, with marked dyspnea and a pulse rate of 150 a minute, and if the dyspnea and pulse acceleration last more than a

minute, then this reaction is considered excessive. A moderately increased reaction lies between the two. By combining the patient's symptoms after her ordinary exertions with her reactions to the foregoing exercise, Pardee places all pregnant patients with organic heart disease in groups 1-4, and by this rates the degree of impairment of heart action.

Carr in 1938 (12) stated that this procedure appears to be very successful in Pardee's hands. However, he and Hamilton are of the opinion that the pulse rate and respiration are much too variable, even in normal individuals, to be accurate guides to the heart's functional capacity.

The classification of the American Heart Association is the outcome of Mackenzie's teaching and has certainly influenced the opinions of most modern cardiologists. In obstetrical cardiology it has met with the support of Pardee (59), Eastman (25), Carr (12), and Stander (76). It is:

Class I Patients suffering from organic heart disease, able to carry on ordinary physical activity without discomfort.

Class II Patients suffering from organic heart disease, unable to carry on ordinary physical activity without discomfort.

a. Activity slightly limited.

b. Activity greatly limited.

Class III Patients suffering from organic heart disease showing definite symptoms of heart failure when at rest.

This classification should not be confused with the one used by Bramwell (3) and Hamilton (33). Like that of the American Heart Association, it has three classes, but these have an entirely different significance - Class I includes cases of severe heart disease, Class III "possible heart disease".

In Stander's (76) series of 436 women during 493 pregnancies (1932-1937) 50.5% of the cases were found to fall in Class I (American Heart Classification), 37.3% in Class IIa, 10.4% in Class IIb, and 1.8% in Class III. In other words half of the patients belong in the mild Class I, whereas the other half falls in the potentially or actually dangerous groups. Sometimes as a pregnancy advances a patient must be transferred from a more to a less favorable class.

Valuable as such a method of classification may be, the prognosis in heart disease and pregnancy is too complicated to be entirely determined thereby. Many factors are important enough to deserve special consideration. For the purpose of any comparison the gross

death rate must be known and understood. This will be given later.

By totaling the cases reviewed by the following men (series of 1,428 cases) the prognostic value of classification on a functional basis is definitely indicated: Gilchrist (30), Pardee (59), Lamb (44), Naish (56), Darchinan and Kornfeld (19), and Hanley and Anderson (34). The total death rate found by summarizing this material is 3.43%. There is a death rate of less than 0.5% in Groups I and II (American Heart Classification), rising to 5.33% in Group IIb, and to 22.61% in Group III. The various causes of death should be considered as well as the time thereof in relation to conception and delivery, that it may be known what to fear and when to fear it. Age, the anatomical lesion of the heart, twin pregnancy, and hydramnios have all been thought to affect the prognosis.

Bramwell (3) believed that the most important general considerations as regards prognosis are:

- (1) The presence or absence of heart failure and auricular fibrillation, (2) the extent of the structural lesions, and (3) the temperament and economic circumstances of the patient, that is to say, her willingness and ability to adapt her mode of life to the limitations of her damaged heart.

The present material indicates that the prognosis grows worse with advancing age. This is not surprising - the maternal death rate and the death rate from heart disease increase with advancing age. Jensen (39) believed that the proportionate increase in death rate from heart disease and pregnancy does not exceed what might be expected among women without heart disease, and there is no evidence that pregnancy, as such, has increased this death rate.

Strayhorn (77) in 1935 wrote, "That with close cooperation between the internist and the obstetrician the outlook is not as bad as has been presented in the past. Neglected, the dangers are just as great, and the mortality just as high".

DeLee in 1935 (21) stated that pregnancy exerts but slight harmful influence on rheumatic heart disease, but, on the other hand, that these women do develop decompensation and die sooner than other women and men with similar cardiac disease. He feared it with pregnancy, for even though the patient is brought through delivery and puerperium alive "the dangers which threaten at every step are very disquieting".

There is some similarity between the problems involved when a patient with heart disease becomes pregnant and when one is to undergo a surgical operation.

There is one important difference, however, in that the former condition is to a great extent predictable and voluntary. This increases the responsibility of the physician for he will be asked whether pregnancy should be contemplated, or after it has occurred whether it should continue. The intelligent answer to these questions will require not only a knowledge of diagnosis and prognosis of heart disease, but also an insight into the social and economic life of the family involved. (45) Scott and Henderson (70) believed that it was at least questionable whether the average age of death of a large group of rheumatic heart cases is shortened by pregnancy if the economic position of the patient is considered.

The first man to consider prognosis from this standpoint was Hamilton (33) who in 1923 wrote that in determining whether or not a patient with a damaged heart should attempt to go through a pregnancy and labor, the physician should first find out whether she is equipped mentally, and also financially, to spare herself as much as necessary. If she is not, the risk becomes immeasurably greater. In estimating the ability of a heart to stand strain, it is important to know how much strain it has already been made to stand and how successfully it has done this.

If the mother is suffering from active rheumatic fever, it is undesirable that she be pregnant at that time. Apart from any ill-effects that the pregnancy may have on the mother, and it is not certain that there are such ill-effects, the child may be born with a rheumatic carditis. Levine (45) has reported instances of acquired intra-uterine rheumatic heart disease.

Of first importance is the state of compensation of the circulation. If there is any evidence of congestive heart failure or if such failure has once been present in the past, Levine believed it best to advise that no further pregnancy be undertaken. Even when an apparently satisfactory state of compensation can be established by appropriate medical treatment, the risk of recurrent heart failure is too great and the life expectancy of the mother is too short to make it advisable for such a woman to go through pregnancy. If it is undertaken, a high maternal mortality must be expected.

Strayhorn (77) supports this opinion in that if a patient has ever had cardiac failure she should be strongly advised against marriage and certainly against pregnancy.

On the other hand if there is no objective evidence of heart failure, or dyspnea is either entirely absent or only of a slight degree, patients with mitral stenosis, aortic stenosis, or aortic insufficiency should be permitted to go through pregnancy. The only exception to this is in the presence of auricular fibrillation which will be discussed later.

There are differences in the advice which the physician should give when the question of the first or of subsequent pregnancies arises. What has been said above concerning well-compensated cases of aortic or mitral disease applies primarily to those women who contemplate their first pregnancy. According to Levine, even when there is some doubt as to the exact state of the heart a slight added risk may be hazarded for the joy of having a child in contrast to a childless life. The situation is not quite the same if the patient has one or more healthy children. Realizing that there is always a slightly greater risk among pregnant cardiacs than among normal women, no matter how apparently trivial the disease may be, Levine feels that if there are already three children, under no circumstances should any more pregnancies be undertaken. He stated that it is not pertinent to the question to recall the instances in which women with mitral stenosis

have satisfactorily borne eight or ten children. "We only see as living patients those who have survived. Many of the other multipara have succumbed and no longer are here, leaving their surviving children motherless." (45) Darchinan and Kornfeld (19) found "that the fact that one pregnancy does no harm is no proof that another will not". In fact, they found the reverse to be true.

It must be remembered that there is a strong familial factor in rheumatic heart disease and that with numerous pregnancies there is a great likelihood that one or more of the children will eventually suffer from rheumatic heart disease. According to Levine (45), "If precautions are taken in families with stigmata of important hereditary nervous disorders like insanity, why should not similar considerations be given to this disabling form of heart disease?" Furthermore, with numerous pregnancies among people of humble or modest means, the task is not finished with recovery from the confinement. The rearing of several infants and children without the aid of nurses and maids may prove to be a greater task than the pregnancy itself, and more than the disabled heart of the mother can stand.

According to Danforth (18) the patient should be advised so that pregnancy will take place during the

early years of married life. Unless some acute episode has taken place, the cardiac condition does not generally improve with advancing years so that a pregnancy will be better borne earlier rather than later.

All women with organic heart disease should be cautioned to consult their physician at the first suspicion or indication of pregnancy, so that a decision may be made early during the pregnancy.(45)

According to Pardee (60) in 1922 the problem of prognosis is fundamentally difficult, for the physician is called on before pregnancy or during the early months to say what will be the reaction of the heart some months later to a strain whose severity cannot be truly predicted. The latter feature is one of the most vital parts of the problem, for there will obviously be a very different degree of circulatory strain in a labor lasting 24 hours from a precipitate delivery.

The conclusion, which is based on modern literature, is that prognosis should be governed by the functional capacity of the heart rather than structural change. From this conception has arisen the classification of the American Heart Association which, to avoid the confusion of past years, should be adapted universally, as is gradually occurring. From the standpoint

of prognosis the patient's social and economic position should be considered. It is undesirable that pregnancy should take place if the patient has active rheumatic fever. The consensus of opinion is that if a patient has any evidence of congestive failure or it has ever been present in the past, pregnancy is contraindicated.

AURICULAR FIBRILLATION

According to King (43), Bramwell (3), Levine (45), Niehaus (62), and Jensen (41), auricular fibrillation in the childbearing age almost always occurs in association with rheumatic heart disease. The proportion of cases due to hyperthyroidism and other causes is quite negligible.

King (43), DeGraff and Lingg (20) found that the duration of life after the onset of fibrillation is usually not over two years. This should influence the attitude toward pregnancy for a child born to such a patient will surely be left without a mother before it is out of childhood. In DeGraff and Lingg's experience auricular fibrillation does not usually come on until eighteen years after the onset of valvular heart disease, and the average age of death is 38 years. It is a terminal manifestation appearing late among those patients with rheumatic heart disease who survive for a long time. This experience seems also to apply to obstetrical cases, for 6 out of Carr and Hamilton's (11) 14 patients, and 6 out of Robinson's (66) 18 were aged 35 or more. The average age of Naish's (56) pregnant patients with auricular fibrillation was 35 years.

There are good reasons to take a serious view

of this condition in obstetrics. It indicates a stage in rheumatic heart disease which must be evaluated much in the same light as the onset of congestive failure, i.e., that it marks the beginning of failure. It is considered an absolute bar to undertaking or continuing pregnancy by Campbell (10), Hamilton (33), Kellogg (41) Bramwell (3), and King (43). As early as 1904 Mackenzie (48) called auricular fibrillation a contraindication to pregnancy but it was not again mentioned until 1921.

Jensen (39) related that no such positive statement can be made and that the decision should rest on consideration of all circumstances. According to him, if this condition responds to digitalis and if effort does not cause excessive tachycardia, it does not preclude successful pregnancy, though it does render the prognosis less favorable.

If pregnancy is already present in a fibrillating patient when she presents herself, Bramwell (3) believes it should be terminated in the first three months. If she does not come under supervision until the pregnancy is well advanced, emptying the uterus is then a more serious matter. In these circumstances the safest course is to wait until the child is viable, and then terminate the pregnancy either

by Caesarian section or by induction of labor. If heart failure has set in and is attributable to auricular fibrillation, confinement to bed and treatment with digitalis is indicated.

King (43) stated that sometimes a patient should be carried through the pregnancy if (1) the desire for a child is great, (2) the parents are fully aware of the risk involved, and (3) if the cardiac reserve seems good and (4) if the ventricular rate can be controlled with digitalis.

In Bramwell's (3) series of 16 cases, he had a death rate of 6 or 38%, and of Carr and Hamilton's (11) 14 patients 6 or 42% died before or during delivery. These two series (30 patients) were taken from a total of 800 rheumatic heart cases, thus indicating the relative infrequency of this condition. DeGraff and Lingg (30) followed 190 cases of auricular fibrillation to the end and found that only three survived respectively for 10, 11, and 12 years following delivery.

Auricular fibrillation has a double significance. It may be evidence of severe damage to the heart muscle and for that reason it adds to the seriousness of the prognosis. Second, uncontrolled auricular fibrillation impairs the circulation through inefficient and wasteful action of the heart. Both of these aspects

should be considered in the management of pregnant patients.(39)

In conclusion, auricular fibrillation is a contra-indication to pregnancy. If pregnancy has already occurred when first seen, it should probably be terminated.

COMPLICATIONS OF RHEUMATIC HEART DISEASE IN PREGNANCY:
STATISTICS OF RESULTING MORTALITY

No better impression of the importance of rheumatic heart disease in pregnancy can be gained than by studying the part it plays in maternal mortality. It is one of the most important causes of death in connection with childbearing, possibly the most important cause of death in labor. (84) The mortality rate as recorded in the literature has shown a steady decline from the first data written approximately 60 years ago until the present time.

Angus Macdonald (46) in 1878 reported a mortality of 64.4% in his small series of cases. These figures were copied for about 20 years until Wilson (89) in 1899 stated that 40% of parturient women suffering from heart disease succumbed from the complications of labor. Of Hicks and French's (27) series of 300 cases of mitral disease reported in 1907, there was a mortality rate of 13.9%; and of 453 cases collected and reported by Breed (5) in the same year - 12%. Between 1907 and the present time, most statistics varied from 8% to 10%. This has now been reduced to about 2% to 3%, according to Gulick (32) and Hamilton (33), which at present seems to be an irreducible minimum. This is ten times that of pregnant

women without heart disease.

No comparable death rate is available for rheumatic non-pregnant cardiac women, but from DeGraff and Lingg's (20) material it seems probable that it is near 7%. Considering that this is an annual death rate while that for pregnant women covers a shorter period, they consider it probable that the death rate in pregnancy nearly equals what would be expected among a similar group of cardiac patients who were not pregnant. But the fact that the two death rates are of the same order of magnitude does not mean that they have exactly the same significance, for, even apart from pregnancy, the two groups of patients would not be strictly comparable. It has often been observed that a cardiac patient does not usually conceive after the onset of congestive failure. The period of failure often extends over several years. It is therefore probable that apart from the pregnancy those women who become pregnant are somewhat healthier than those who do not.(39)

King (43) and Turino (80) record statistically that rheumatic heart disease is among the first four or five important causes of maternal death, and probably accounts for about 7% of all fatalities. Stander (76) placed it fourth, with only hemorrhage, infections, and pneumonia producing more maternal deaths. Eastman (25)

believed that only toxemia and sepsis claim more lives during pregnancy and puerperium.

Representative figures of the incidence of deaths of rheumatic cardiac patients have been given. What are the most frequent complications which cause these deaths?

By far the greatest number die from congestive failure, which develops in about 20% of cases. Carr and Hamilton report 19.2% (36); and, according to Jensen, (39), Fromme - 21.4%.

According to DeGraff and Lingg (30), King (43) and Hamilton's (33) series, congestive failure in rheumatic heart disease is the cause of death in 60% to 70% of the cases. While this is responsible for most of the deaths, the majority of cardiac patients who develop heart failure during pregnancy recover compensation.

Fatigue should probably head the list of factors predisposing to congestive failure. King (43) and Easley (23) found that many women in this group had been advised to walk or exercise in some manner to keep up muscle tone, when they should have been restricting their activities to a minimum. Another important factor in precipitating failure is an intercurrent infection which usually means an infection of the respiratory tract.

In any of these patients a simple "cold" or sore throat should be taken seriously and the patient put to bed immediately. A factor of perhaps lesser importance in favoring congestive failure is a gain in weight. This can usually be controlled by diet, as it puts an added load on the heart. Anemia may be another infrequent cause.(33)

It is the impression of several authors that the earlier congestive failure occurs the worse the prognosis, and that congestive failure advances faster in pregnant women.(39) In the series of cases presented by Jaschke (36), Carr and Hamilton (11), Meares (54) and Naish, McIlroy, and Rendel (56) it appears that congestive failure occurs most often during pregnancy, but that many of these patients deliver prematurely. Comparatively few cases become decompensated during labor, and decompensation appearing in the puerperium is the exception. This experience would justify Jaschke (36) and Henderson's (70) statement that absence of decompensation during pregnancy is generally a sign that the heart has strength enough for labor. But pregnancy lasts many months while labor rarely lasts more than a day. If this is calculated, not per phase of gestation but per unit time, it is distinctly increased during labor; and it is still lowest in the puerperium. Naish (56) and

Fitzgerald (26) found that where heart failure does occur following delivery in patients who have not had it before, some additional serious complication is back of the failure - pulmonary emboli and pneumonia have been found to be the exciting factors in a few cases. Undoubtedly labor carries a real danger of congestive failure to the cardiac patient. (36)

A large number of the remainder of deaths (about 30%) are due to pulmonary causes, mainly pulmonary edema. Pulmonary edema often occurs complicating congestive failure, as shown in a reported study of 135 cases in which it occurred alone in one-third and as a complication of congestive failure in two-thirds of the cases.

Pulmonary edema is particularly prevalent during labor and during the first 24 hours after delivery. It is due to a formation of a vicious circle involving pulmonary congestion and respiratory stimulation resulting in increased ventilation. It usually occurs in mitral stenosis as a result of this lesion obstructing the blood coming from the lungs. It may be due to exhaustion of the left ventricle from the strain of labor. For some poorly defined reason, it seems to be more frequent among young women and in primiparae.(43)

Thorne (79) in 1918 reviewed an article by Sir James Mackenzie, and reported him to have described the signs of heart failure as a sensation of insufficiency on the part of the patient, dropsy, breathlessness, edema of the lungs and persistent increase of heart rate. Thorne pointed out the necessity of diagnosing it in its earlier stages that treatment may be effective. However, also in 1918, Sir James Mackenzie (49) made the same criticism of other authors; and related that the earliest signs of heart failure are persistent rales at the lung bases. Thorne maintained that the first sign of cardiac failure is cardiac dilatation, which can be diagnosed by the extension of the area of cardiac dullness on the right. At any rate, the typical picture has changed with the years, as is shown by Hamilton's statement (33): "Congestive failure no longer means the patient described by Macdonald, but an almost subclinical condition discovered by the examining physician."

Levine in 1936 does not attempt to give one sign as the earliest evidence of weakening of the circulation.(45) He described it as a slight increase in the dyspnea, a slight nonproductive cough, and the presence of a few rales at the bases of the lung. Inasmuch as some subjective dyspnea may have been present before the pregnancy occurred and many women without

heart disease may complain of slight dyspnea during pregnancy, it is no simple matter to appraise this symptom. Levine and Hamilton (33) use the vital capacity of the lungs as an index of measurement. They found that when a case is progressing favorably, the vital capacity will remain essentially unchanged throughout pregnancy; and that even at the eighth month when the abdomen is markedly distended by the enlarged uterus, it does not impede the movements of the diaphragm sufficiently to lower the vital capacity. They regarded pitting edema of the legs as not trustworthy because many women manifest this as a result of pressure of the uterus on the pelvic veins.

The conclusions may be listed as follows:

1. The present death rate of pregnant patients with rheumatic heart disease is ten times that of women with normal hearts.
2. It is probably among the first 4 or 5 causes of maternal mortality.
3. Congestive failure develops in approximately 20% of cases and is the cause of death in 60% to 70% of the cases.
4. Pulmonary edema accounts for the majority of the remainder of deaths (about 30%).

5. The complications of heart disease should be diagnosed early in their appearance that prompt treatment may be instituted.

MANAGEMENT OF PREGNANCY AND DELIVERY

Management During Pregnancy

The fundamental treatment of heart disease in pregnancy is rest. This was mentioned in the earliest literature to be found on the subject. Its importance was stressed by Malherbe in 1867 (50), Macdonald in 1877 (46), Hart (35) and Fry (28) in 1888, Sears in 1894 (71), Wessinger in 1896 (83), and Wilson in 1899 (89). The general consensus of opinion of men in the last part of the 19th century was, as Wilson pointed out, that the patient should lie down an hour each day if the cardiac disturbance is slight, and the greater part of the day in advanced cases. He also indicated, which supports the opinions of Daly and Strouse (15) and Mackenzie (49) of today, that mild cases are benefited by a certain amount of regular exercise in the form of walking on the level. "Any distress, however is an indication that effort must cease." (17)

Likewise in 1938 Bramwell wrote that rest is prescribed, not because a patient has heart disease, but because she has signs of heart failure. In the absence of heart failure, exercise in moderation is beneficial, it aids the venous return to the heart - "the heart,

like other muscles, needs to be kept in training". Inactivity in patients with heart disease has a detrimental effect on the circulation.(4)

The two most important precautions in preventing heart failure are the avoidance of over-exertion and special care in the event of even apparently trivial intercurrent infections.(48) "The keynote of preventing heart failure is adequate ante-natal supervision." (11)

Patients must, of course, avoid conditions which throw a strain upon the heart - as, for example, mental worry, straining at stool, and digestive troubles.(48)

Bramwell and Longson, whose opinions are in accord with all modern authors on this subject, feel that exercise in the presence of heart failure would be causing a badly damaged heart to increase its output, which is "like whipping a tired horse". To reduce metabolism, until the requirements of the tissues no longer exceed the cardiac reserve, is often within the power of the physician - thus the "heart's liabilities are diminished and it is enabled to balance its budget." By rest the heart muscle is given a chance to recuperate.(4)

During the latter part of pregnancy, special attention should be paid to dyspnea, tachycardia, engorgement of the veins of the neck, enlargement of the liver, persistent moist sounds at the lung bases, and edema. If these are recognized early a few days in the hospital or at home will generally suffice to restore the normal balance.(3) Fitzgerald (26) believed that anything which gave evidence of myocardial distress was sufficient to call for hospitalization.

During the time it is necessary for a patient to be in bed, Mackenzie (43) stressed the importance of having the patient sit up or lie propped up, because lying down tends to hamper the circulation in the bases of the lungs by restraining the movements of the ribs. At times during the day she should be made to breathe deeply, in order to assist the right heart in expediting the flow through the lungs.

Besides rest, which is the most important therapeutic measure, digitalis should be instituted according to the physical findings. It is not always necessary in the milder forms of the disease when the pulse remains regular and slow. (32) There is a difference of opinion as to when it should be used, and most cardiologists have advised against it except in decompensation. Digitalis is a powerful poison and its

routine use over a long period of time may possibly result in myocardial damage.(39) Mackenzie, however, recommended that it be given a trial if the heart rate is accelerated.

In the decompensated heart, digitalis therapy should be promptly instituted. The dose should be effective and, according to Jensen (39), 0.3 gram of the powdered leaf three times is not too much for the first day. Mackenzie (48) recommended 15 drops four times a day. Later, dosage should be determined by the progress of the case. After compensation is restored, a maintenance dose should probably be continued until delivery.(15)

The presence or onset of auricular fibrillation should be treated as if falling into a more severe class than that to which she has been assigned according to her functional capacity.(32) It is in this condition that the good effects of digitalis are obtained. Here digitalis slows the heart and the individual beats become strong and effective. The circulation is thus at once greatly improved. When the heart responds to digitalis and the rate falls to 70 or 90, the drug should be suspended, and only resumed when the rate begins to increase. The quantity sufficient to keep the rate about 70 should be determined by giving and withholding the drug during

a period of a few weeks. There is quite general agreement that then the patient should continue for the rest of her life to take the quantity which keeps her heart beating at a normal rate. (48)

Flatulence is often a distressing symptom in pregnant cardiac patients. It can best be avoided by taking meals in a dry state so as to compel thorough mastication. Meals should be small in quantity and frequent.(48) According to Corwin and Herrick (14) the compensated heart case requires no special dietary regulations during pregnancy. Obviously, the stomach should never be overloaded. With regard to the diet in cardiac failure, Smith, Gibson and Ross (72) emphasized the necessity that it provide sufficient energy. They recommended 2100 calories, consisting of 44 grams of protein, 110 grams of fat, and 222 grams of carbohydrates. The fluid intake should be limited to 1500 cc. and the salt reduced to a minimum. They employed this diet in the treatment of 50 patients in whom they maintained that it alone effects an elimination of the excess fluids with an associated improvement in the general condition.

In 1907, Hicks and French (27) advanced the popular aphorism that the treatment of a case of pregnancy complicated by heart disease is the treatment of the heart disease. Breed agreed with them but added

that the patient should also be relieved of the strain produced on the heart by the pregnancy by the induction of abortion in some cases, or by the induction of premature labor in others.(5)

Premature Interruption of Pregnancy

Jensen (39) gives an extensive review which includes 300 references in the literature with regard to the premature interruption of pregnancy for heart disease. The first material was written in 1827, at which time and for many years thereafter the interruption of pregnancy was strongly opposed. This opinion stood until Leyden of Berlin in 1893 pointed out that the bad results in the past had been due to the manner in which the method had been employed and not to the procedure itself. He suggested that the pregnancy be interrupted before the patient was moribund - as soon as it was certain that heart failure would not yield to medical treatment. This procedure slowly gained acceptance.

By 1899 Rosenberger and Wessinger (83) were of the opinion that induction of premature labor should be carried out in serious heart disease, because each week that the patient continues in the pregnant state places her life in greater jeopardy. "If then the case

ends fatally, you can console yourself with the belief that the woman succumbed not through but in spite of premature labor."

There followed in the first part of the 20th century (up to about 1917) what is now believed to be a too free use of the procedure. Kellogg's emphatic statements in 1917 (40) were of a more conservative nature. He believed that "there was never a case of valvular disease of the heart and pregnancy whose circulatory efficiency was not improved by rest and medical treatment, unless moribund. But that there comes a time in the treatment of every case of decompensated heart disease when the circulatory efficiency has been raised to a point where it is either fit to continue pregnancy or where the patient must be forthwith delivered, because she is now at her high point as an operative risk."

In a general way, Hamilton (33), Pardee (60), and Herrik's (14) writings show that they follow Kellogg and his more conservative conclusions. Herrick in 1927 wrote that medical measures should always be tried in a decompensated patient. If compensation cannot thus be restored a grave situation is present for "without delivery, the patient may die; with forcible delivery she will almost surely perish. In this

medical impasse, it is usually best to trust nature more, and art less."

King stated that with our improved understanding of the problem and increased intelligence on the part of the public, physicians will be called upon to face this problem less frequently in the future "for either a woman should not undertake pregnancy or she should be capable of carrying it through".(43)

At the present time the indications for premature interruption of pregnancy in heart disease seem well established. They were best expressed by Pardee (61) at the meeting of the American Medical Association in Cincinnati in 1934. A brief summary of this will be given. The classification used is that of the American Heart Association. (1) Class IIB, which is not improved by treatment in a patient during the 5th, 6th and 7th months of pregnancy is an indication for therapeutic abortion. Exceptions to this may be made for some patients on the grounds of their mental reactions, willingness to cooperate, and economic circumstances. (2) Class II B, which is not improved by treatment in a patient during the first 3 months of pregnancy is an even more imperative indication for abortion. This patient faces the possibility of more marked cardiac insufficiency later in pregnancy if allowed to continue.

(3) Class III must be treated medically before the subsequent procedure is decided on. (4) Patients having auricular fibrillation must be considered as running a greater risk than others in the same functional class.

Management of Delivery

The literature abounds with advice on how to conduct labor in cardiac patients. Much of it is based on theoretical premises. Nothing would be gained by an historical review of such management in that practically every method used today was also used as early as material was written on the subject. Some measures have been devised which help the physician in troublesome situations.

As long as there is no evidence of cardiac embarrassment, there is no reason to modify routine procedures of labor, except that the patient should be supervised with more than usual care. (18)

Stander in 1938 (76) divided the types of delivery of cardiac patients into spontaneous and operative. Operative deliveries include forceps delivery, therapeutic abortions, Caesarian section, and Caesarian section with sterilization. In his series of 493 deliveries he found that spontaneous delivery occurred in 76.3% of Class I; 66.4% of Class II A; 45.7% of Class II B;

and 0% of Class III. Operative deliveries were 4.7%, 21.6%, 51.4%, and 100% in the respective classes. This shows quite well the relative frequency of the general type of delivery in use today but he realized "that the decision as to type of delivery, as well as to sterilization, rests on many factors and is an individual matter in each patient".

It has been commonly observed that labor frequently sets in as early as the 7th month in cardiac patients (48), so that the birth is accomplished with little stress on the heart. There is no convincing evidence that the duration of labor is affected by the presence of heart disease, but the statement that it is shortened seems to be more frequently found. Meares (54) suggested that in congestive failure the short labors may be due to the soft and congested state of the cervix and vagina. Turino (80) and Darchinan and Kornfeld (19) found and recorded their series of cases in which labor was somewhat prolonged.

The relief afforded to orthopneic patients by the semirecumbent position resulted many years ago in the suggestion that all cardiac patients should be placed in an upright position during labor. Wessinger and Rosenberger (83) advised this in 1899 "in order to give the heart the greatest possible working space".

That it be assumed at the first sign of cardiac embarrassment, especially dyspnea, has been again stressed in recent years.(25)

There appears to be no disagreement that rapid digitalization should be effected when cardiac symptoms arise during labor. The drug should be given intramuscularly for rapid action.(43) According to Carr (12) rapid digitalization, phlebotomy, and the administration of oxygen all seem proper, but that they are only too often "ineffective gestures". Jensen (39) urged that, due to the effect of morphine on fetal respiration, it should be delayed until just before delivery; while Mackenzie (49) advised its liberal use during labor. Mackenzie found that some patients struggled and moved about so actively while under the influence of barbiturates that they undoubtedly placed a great deal of strain on the heart. In these patients "amnesia is of less importance than the diminution of physical and nervous strain".

Since 1900 the use of Caesarean section has been greatly developed. If performed before labor is far advanced, it is the safest way of relieving an embarrassed heart of the strain of labor. If the cardiac symptoms are progressing, forceps delivery is indicated late in labor, Caesarian section early. As stated by Danforth (18) Caesarian section should not be a frequent method of

delivery in heart cases. For women whose hearts are well compensated it is not necessary, and for those whose cardiac function is less than normal it is often unwise and "we are now trying to avoid Caesarian sections at term for cardiac reasons alone".⁽³³⁾ It has been surmised that convalescence after section is often harder upon the patient than labor would have been. The distention and vomiting which is so often a part of the recovery from this operation makes heavy demands upon the physical strength of the patient.

Meares (54) stated that medicinal induction owing to the distress it would cause the patient and its likelihood of being unsuccessful, is contraindicated in congestive failure. Moreover, Meares believed that induction of labor by bougies or any other method involving an anesthetic is inadvisable; and according to him Lennie found that the maternal death rate after such interference was as high as 44%. Induction of labor by rupture of membranes does not expose the patient to the same risks, if obstetrical conditions are normal.

The treatment today of that most dramatic event during labor - pulmonary edema - is the same as it was many years ago. Venesection and morphine were used by Hart in 1833 (35) and, according to him, by Ramsbotham in 1854, and although it fell into disuse for

several years, its value is again recognized.(45) It is definitely indicated in embarrassment of the right heart. Amyl-nitrite was also used by Hart and many men up to the present time to relieve the heart by peripheral vasodilatation. Morphine should be given in full doses in pulmonary edema. Because of its depressing effect upon the respiratory center, it helps to break the vicious circle between overaction of that center and the pulmonary congestion. Jensen (39) and King (43) also recommended digitalis, but many authors have argued that such pulmonary edema results from left auricular failure, and that digitalis may do harm by strengthening the left ventricle more than the auricle and thus increase the pulmonary congestion.

Sterilization is indicated in heart disease when a woman has had as many children as she can physically manage. Fundamentally, it depends on the stage of the heart lesion. Caesarian section and sterilization has met with considerable favor with many obstetricians and cardiologists. Early in the course of rheumatic heart disease (Class I and possibly Class II A) this may be done after several pregnancies. If the cardiac capacity is considerably restricted (Class II B) this procedure may be advisable with the first pregnancy. There is general agreement that the desirability of sterilization

should not warrant adding additional risk. However, with marked restriction (Class III), if circumstances are such that the pregnancy is continued, and abdominal section is chosen as the preferable method of delivery, sterilization then seems very desirable. For the patient who must have her pregnancy terminated in the first trimester, sterilization should not be accomplished until a later date when her condition permits and when the mortality is lower. It has been suggested that in classes II B and III it would be more feasible to sterilize the male, than subject his mate to further hazard.(57)

Turino (80) advised that any patient who is subjected to Caesarian section for cardiac reasons should be sterilized with the one exception - patients with active rheumatic fever, whose pregnancies are interrupted because of the active infection. These patients may be able to bear children safely at a subsequent time.

A word should be said about the choice of anesthesia for delivery. There is general agreement that compensated rheumatic valvular disease of the heart does not alter the choice of the anesthesia, and at the present this choice seems to vary with individual preference and custom. The death rate from operations on patients with compensated rheumatic heart disease

is similar to the general surgical death rate.(39)

A few definite contraindications that the majority of authorities have observed were given by Bramwell.(3) When local anesthesia is used, adrenalin should not be combined with novacaine as its effect on the circulation is undesirable. Spinal anesthesia has few advocates for use in the delivery of rheumatic heart patients, its chief drawback being the lowering of the blood pressure which results from vasodilation of the anesthetized segments. King and Herrman (43) considered that in the presence of pulmonary congestion, ether predisposes to pulmonary edema.

"The delivery of patients with heart disease is expressed in the judgment and skill that has been displayed in prenatal management, long before the serious crises at delivery has arisen."(12)

Conclusion

As to the management of pregnancy and delivery of rheumatic heart cases, a few quite definite conclusions may be made.

1. Close observation of these patients is necessary, with constant vigilance for the first signs of decompensation, and special care in the event of any infection.

2. In the absence of heart failure, exercise in moderation is beneficial.

3. The treatment of heart failure is rest, digitalis, and dietary management.

4. The indication for interruption of pregnancy is heart failure which does not respond to treatment.

5. There is no convincing evidence that the duration of labor is affected by the presence of heart disease.

6. Progressing cardiac symptoms indicate forceps delivery late in labor, Caesarian section, early.

7. Sterilization is indicated in heart disease when the patient has had as many children as she can physically manage. This may be done at the time of Caesarian section, though the desirability of sterilization should not be an indication for section.

8. Choice of anesthesia for the cardiac patient probably depends upon the type with which the person administering it is thoroughly familiar.

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